Research Article

The use of inferior vena cava filters in spine trauma: A nationwide study using the National Trauma Data Bank

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Objective: To determine the prevalence and variation of inferior vena cava filter (IVCF) use in the spine trauma population and evaluate patient and facility level factors associated with their use.
Study Design: Retrospective cohort.
Participants/Outcome Measures: Patients with spinal injuries were identified by ICD-9 codes from the National Trauma Data Bank (NTDB), the best validated national trauma database. Patients whose spine injuries were operatively treated and those who received IVCF were identified from procedure description fields. Additional information compiled included patient demographics, injury severity score (ISS), time until surgery, concomitant fractures, and facility level information. Multivariate logistic regression analyses were conducted to examine the relationship of associated factors for IVCF use.
Results: Of the 120,920 patients identified with spinal injuries, 2.4% received prophylactic IVCF. Of the 13,273 patients with operatively treated spinal injuries, 8.2% received prophylactic IVCF. Of the 7,770 patients with spinal cord injury (SCI), 10.8% received prophylactic IVCF. The interquartile ranges of placement rates among centers demonstrated greater than 10 fold variation. Based on multivariate logistic regression, ISS score >12 demonstrated the strongest association with prophylactic IVCF (adjusted OR = 4.908). Concomitant pelvic and lower extremity fractures (adj OR 2.573 and 2.522) were also associated with their use.
Conclusions: Currently the only data regarding existing IVCF use in the spine trauma population amounts to surveys. The present study provides the most detailed and objective information regarding their use in this setting. Even in the operatively treated and SCI subgroups, prophylactic filters were used in only a small percentage of cases but placement rates varied widely among centers. More severely injured patients (ISS >12) had highest odds of receiving prophylactic IVCF. Further study is needed to clarify their role in this vulnerable population.

Keywords: Spine trauma, Spinal cord injury, Vena cava filter, Thromboembolic disease, Pulmonary embolism

Introduction

Venous thromboembolic disease is a common problem in the injured patient. Patients with spinal injuries frequently have concomitant head or visceral injuries and long bone or pelvic fractures, all of which may lead to prolonged recumbence. Patients undergoing major spinal procedures and those with spinal cord injury are at particularly high risk for thromboembolic events, and in rare occasions these may be fatal.[1–4] Conversely, in operatively treated spinal injuries, clinicians may be reluctant to initiate chemical prophylaxis soon after surgery due to the low but catastrophic risk of epidural hematoma[5,6] and the moderate risk of wound complications.[7] These concerns and the lack of high level data have resulted in a glaring lack of consensus regarding the method and timing of pharmacologic prophylaxis.

The use of inferior vena cava filters (IVCF) is favored in this setting by some clinicians. Patients who develop VTE in the postoperative setting may be treated with IVCF to avoid the need for therapeutic level anticoagulation, which may have an even higher risk of bleeding related complications.[7] More commonly, IVCFs are used prophylactically as an alternative to early administration of chemoprophylaxis, or as an adjuvant fail safe

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in preventing pulmonary embolism. While prophylactic IVCF insertion has been associated with a lower risk of PE in trauma patients in level III studies,[8,9] significant controversy exists regarding this practice.[10,11] Given the lack of consensus, we sought to determine the prevalence and variation of IVCF use in the spine trauma population using the American College of Surgeons National Trauma Data Bank Research Data Set (NTDB RDS). In addition, we wished to evaluate if there were certain patient, injury, and facility related factors that were associated with increased odds of filter placement.

Patients and methods

A retrospective cohort study was performed using the NTDB RDS from the year 2012, the most recent year for which complete data was made available at the time of initiation of the investigation. The study was deemed exempt from our institutional review board. Access to the data was granted with permission from the American College of Surgeons. This is the largest database of trauma patients, with more than 900 contributing centers nationwide. The database contains more than 100 data elements compiled from both administratively coded and medical record abstracted data. The dataset is subjected to quality screening for consistency and validity.[12] The data are contained in a set relational tables consisting of 20 files which have been purged of all identifying information, ensuring the confidentiality of patients, clinicians, and hospitals.

All patients with spinal fractures and dislocations diagnosed during their initial hospitalization were identified using *International Classification of Diseases, Ninth Revision* (ICD-9) diagnostic codes. Spine fractures were identified by codes 805.01-805.7, encompassing fractures of the cervical, thoracolumbar and sacral spinal segments without neurologic injuries. Vertebral dislocations were identified by codes 839.00-839.30. Spine fractures with neurologic injuries were identified by codes 806.00-806.7 encompassing fractures of the cervical, thoracolumbar and sacral segments with neurologic injuries. From the above mentioned ranges, the following codes were excluded since they refer to injuries of the coccyx or sacroiliac joint or refer to unspecified spinal injuries without detail regarding their anatomic location: 805.80, 805.90, 806.69, 806.72, 806.79, 839.40-839.42, 839.49, 839.50, 839.52. Codes 952.0-952.4, encompassing neurologic injuries of the various spinal regions without identified bony injury, were included. Patients with codes 344.0 or 344.1 (quadriplegia or paraplegia, unspecified) that also had at least one of the other specified codes listed above were considered to have a spine injury with associated spinal cord injury.

From the above established population of patients with spinal fractures and dislocations, we identified those patients who underwent operative treatment of their spinal injuries. From the procedure description field, we searched for ICD-9 procedural codes 81.0-81.08 which encompass spinal instrumentation and fusion codes of the aforementioned spinal regions from both anterior and posterior approaches. Vertebroplasty and kyphoplasty codes were not utilized. The presence of an IVCF was determined by ICD-9 procedure code 38.7 (interruption of the vena cava). The presence of DVT and PE were abstracted from the complications field (complication codes 14 and 21 respectively). As other investigators have done,[13,14] we designated a patient's IVCF as "prophylactic" if neither DVT nor PE was found in the complication or discharge field of a patient with an IVCF. In this manner, we determined the prevalence of IVCF use (total and prophylactic) in the overall population of patients with spinal fractures and dislocations, in the subset of operatively treated injuries, and in the subset of patients with associated neurologic injuries.

Additional patient level information that was compiled included patient age, sex, time until surgical treatment of the spinal injury, injury severity score (ISS), presence of pelvic fracture (ICD-9 codes 808.0-808.9), presence of lower extremity fractures (ICD-9 codes 820.0-826.1), and insurance status. Patients with ISS > 12 on the 2008 Abbreviated Injury Scale (AIS08) were considered as having "Major Trauma" per the findings published by Palmer, *et al.*[15] We also analyzed prophylactic IVCF placement rates at the facility level and whether there was an association between rates of placement and ACS Level I Trauma Center status, University Teaching Hospital status, or geographic region.

Statistical analysis

All analyses were conducted in IBM SPSS Statistics (Version 23.0, 2015). We assessed the prevalence of IVCF placement in our overall study population of spine trauma patients, as well as subpopulations of patients coded for: major trauma; spinal cord injury; fusion; cervical involvement; thoracolumbar involvement; sacral involvement; concomitant pelvic fracture; concomitant lower limb fracture; and DVT/PE. Additionally, we assessed the prevalence of prophylactic IVC filter placement among each of these groups (with the exception, obviously, of patients diagnosed with DVT/PE). Our univariate analyses were conducted via the crosstabulation function. We assessed the association of non-clinical variables with IVCF placement, namely geographic region, insurance status, Level I Trauma Center status, and University Teaching Hospital status via Pearson Chi Square with Bonferroni's correction where appropriate.

We then conducted multivariate logistic regression, in order to determine the relationship of putative associated factors with prophylactic IVCF placement among our study population while adjusting for confounding. Along with the factors enumerated above for our univariate analyses, we included patient age as a covariate. In addition to finding the parameter estimates for each model we conducted the Nagelkerke pseudo-R^2 and likelihood ratio chi-square test to assess model fit. To analyze the potential influence of time until operative treatment of the spinal injury, we categorized timeframes as after 24 hours, after 72 hours, after 99 hours, after 7 days, and after 15 days. Separate multivariate logistic regression analyses were then conducted to analyze the potential association of time until surgery on total filter placement.

Results

We found 120,920 patients that fit our inclusion criteria as having a spinal injury. The mean age was 49.2 years (0-89, SD 22.0) and 60.9% were male, 39.0% female. Of these, 3,773 (3.1%) received IVCF in total, and 2,898 (2.4%) received prophylactic IVCF. Of the identified patients with spinal injuries, 13,273 were treated operatively for their injuries (11.0%). The mean age of these patients was 45.8 years (0-89, SD 19.9) and 69.9% were male, 30.1% female. The mean time from admission to their operative treatment was 70.7 hours (1-2,520, SD 107.8 hours). Of these operatively treated patients, 1,319 patients (9.9%) received filters with 1,083 being prophylactic (8.2% of the operatively treated patients). We identified 7,700 patients with spinal cord injuries (6.4%). The mean age of this group was 44.3 years (0-89, SD 20.7) and 73.7% were male, 26.2% female. Of these patients with spinal cord injuries, 1,025 patients (13.2%) had IVCF placed. Eight hundred forty-three of these were prophylactically placed (10.8% of the SCI population). Table 1 summarizes the prevalence of total IVCF (and prophylactic IVCF) placement in the overall population and each subpopulation outlined in our methods. Since the majority of IVCF placed in all categories were prophylactic, and since this setting likely has more practice variability, the subsequent analyses involved prophylactic IVCF. Analysis by insurance status demonstrated that Medicaid beneficiaries were significantly more likely to have prophylactic IVCF than other payer categories (Table 2).

Facility level analyses of prophylactic IVCF placement rates demonstrated substantial variation among centers. For all spine injuries, the rates of placement ranged from 0-16%, the interquartile range (IRQ) 0-2.02%, and the median 0%. For patients with operatively treated spine injuries, the rates of placement ranged from 0-71.4%, the IQR 0-10.8%, and the median 0%. For spinal cord injury patients, the rates of placement ranged from 0-100%, the IQR 0-11.1%, and the median 0%. Table 3 summarizes the analysis of prophylactic IVCF by geographic region. The Northeast geographic region demonstrated significantly higher frequency of prophylactic IVCF placement. Neither a facility's status as an ACS Level I Trauma center ($P = 0.647$) or as a University Teaching Hospital ($P = 0.445$) was associated with prophylactic IVCF placement.

We displayed the results of our prophylactic IVCF placement multivariate logistic regression in Table 4. Only variables that had significant association upon univariate analysis were included in the model. For the non-clinical variables, Northeast geographic region and Medicaid status were used as referents, given their

TABLE 1. Prevalence of inferior vena cava filter (IVCF) placement in patients with spinal injuries and in designated subpopulations.

		No IVCF		All IVCF		Prophylactic IVCF	
	n	*n*	%	*n*	%	*n*	%
All Patients with Spinal Injuries	120,920	117,147	96.9	3,773	3.1	2,898	2.4
Operatively Treated Spine Injury	13,273	11,954	90.1	1,319	9.9	1,083	8.2
Spinal Cord Injury	7,770	6,745	86.8	1,025	13.2	843	10.8
Major Trauma, ISS > 12	53,263	50,028	93.9	3,235	6.1	2,488	4.7
Cervical Involvement	46,596	44,988	96.5	1,608	3.5	1,258	2.7
Thoracolumbar Involvement	76,900	74,268	96.6	2,632	3.4	1,996	2.6
Sacral Involvement	16,608	15,788	95.1	820	4.9	646	3.9
Concomitant Pelvic Fracture	20,814	19,445	93.4	1,369	6.6	1,067	5.1
Concomitant Lower Limb Fracture	18,389	16,971	92.3	1,418	7.7	1,108	6.0
DVT/PE	2,851	1,976	69.3	875	30.7		

DVT/PE, deep vein thrombosis/pulmonary embolism; ISS, injury severity score.

Table 2. Prophylactic inferior vena cava filter (IVCF) placement by payer category.

	Blue Cross Blue Shield	Medicaid	Medicare	No Fault Automobile	Private Commercial	Self Pay	Workers Compensation	Other
Total Patients	7620	10122	29254	13526	24497	15380	3673	16848
Prophylactic IVCF	211	407	373	444	585	333	126	419
Placement Rate (%)	2.77	4.02	*1.28	3.28	2.39	2.17	3.43	2.49

*Pearson's chi-square: $P < 0.001$.

significance found on univariate analysis. For this model, the likelihood ratio chi-square test was significant at $P < 0.001$ (X^2=4,711.461, df = 9) and Nagelkerke pseudo-R^2 was 0.200. Major trauma status (ISS >12) demonstrated the strongest association (adjusted OR = 4.202), followed by operative treatment (adj. OR = 3.727), spinal cord injury (adj. OR = 3.304), and concomitant pelvic fracture (adj. OR = 2.573). Although statistically significant, the adjusted Odds Ratios of the level of spinal injury, geographic region, and insurance status were considerably less than the factors listed above. In addition, we found that patient age was not significantly associated with prophylactic IVCF placement.

Table 3. Prophylactic inferior vena cava filter (IVCF) placement by geographic region.

	Midwest	Northeast	South	West
Total Patients	30619	20334	44497	24192
Prophylactic IVCF	615	666	1153	457
Placement Rate (%)	2.01	*3.28	2.59	1.89

Pearson's chi-square: $P < 0.001$.

TABLE 4. Multivariate Logistic Regression – prophylactic inferior vena cava filter placement: associated factors.

Factors	Adjusted Odds Ratio (95% CI)	Adjusted P
Major Trauma, ISS > 12	4.202 (3.755-4.703)	<0.001
Operatively Treated Spine Injury	3.727 (3.384-4.105)	<0.001
Spinal Cord Injury	3.304 (2.974-3.672)	<0.001
Concomitant Pelvic Fracture	2.573 (2.320-2.853)	<0.001
Concomitant Lower Extremity Fracture	2.522 (2.315-2.748)	<0.001
Cervical Involvement	1.323 (1.203-1.456)	<0.001
Thoracolumbar Involvement	1.282 (1.163-1.413)	<0.001
Sacral Involvement	1.341 (1.191-1.511)	<0.001
Northeast Region	1.793 (1.634-1.969)	<0.001
Medicaid Payment	1.379 (1.229-1.547)	<0.001
Covariates		
Age	1.001 (0.999-1.003)	0.235

Model Likelihood Ratio Chi-Square: $P < 0.001$.
Nagelkerke Pseudo-R^2: 0.200.

We analyzed the potential influence of the time interval between admission and operative treatment of the spinal injury for IVCF placement by performing an independent two-sample t-test, comparing the mean time until surgery for patients with and without IVCF placement. For those without IVCF, mean time until surgery was 67.24 hours (n = 11,421; SE = 0.9328); for those with IVCF, mean time until surgery was 102.42 hours (n = 1,236; SE = 4.591). The result of the t-test for equality of means (two-tailed, equal variances assumed) was significant ($P < 0.001$). Multivariate logistic regression models evaluating various timeframes for delay in surgery are displayed in Table 5. The odds of filter placement increased with each progressive time point tested through 15 days. For each time category tested, the association of time until surgery was generally not as strong as the other factors reported above for odds of receiving IVCF.

Discussion

The prevention of thromboembolic events in patients with traumatic spinal injuries is a complex issue. The risk of a thromboembolic event in these patients is not well understood, and studies investigating this issue in elective spine surgery are often used for guidance.[16–21] The safe timeframe for the initiation of chemoprophylaxis in spine trauma patients that have undergone surgery is also an area of uncertainty. An online survey evaluating surgeons' practices in this regard was published in 2008 by Glotzbecker, *et al.*[22] A wide range of responses was received with no clear majority established. In another questionnaire based study of spine trauma surgeons, 91% of respondents indicated use of postoperative chemoprophylaxis, but 47% reported experiencing a complication of its use including epidural hematoma, retropharyngeal hematoma, and draining wound hematoma.[23]

Given concerns about early administration of chemoprophylaxis, some surgeons favor the use of IVCF in the setting of spinal trauma. Unfortunately, a similar lack of

Table 5. Multivariate regression analyses considering various time intervals until operative treatment of the spinal injury as factor in prophylactic inferior vena cava filter placement.

	24 Hours		72 Hours		99 Hours		7 Days		15 Days	
	Adjusted OR (95% CI)	Adjusted P	Adjusted OR (95% CI)	Adjusted P	Adjusted OR (95% CI)	Adjusted P	Adjusted OR (95% CI)	Adjusted P	Adjusted OR (95% CI)	Adjusted P
Factors										
Fusion After Timepoint	1.273 (1.099-1.474)	0.001	1.466 (1.267-1.696)	<0.001	1.502 (1.282-1.760)	<0.001	1.605 (1.310-1.966)	<0.001	2.023 (1.462-2.798)	<0.001
Major Trauma	3.106 (2.550-3.784)	<0.001	3.025 (2.483-3.684)	<0.001	3.014 (2.474-3.672)	<0.001	3.025 (2.483-3.685)	<0.001	3.040 (2.496-3.704)	<0.001
Spinal Cord Injury	3.103 (2.677-3.597)	<0.001	3.120 (2.694-3.613)	<0.001	3.091 (2.670-3.578)	<0.001	3.031 (2.620-3.507)	<0.001	2.996 (2.590-3.465)	<0.001
Concomitant Pelvic Fracture	1.685 (1.342-2.116)	<0.001	1.644 (1.308-2.067)	<0.001	1.652 (1.314-2.076)	<0.001	1.663 (1.324-2.089)	<0.001	1.680 (1.337-2.110)	<0.001
Concomitant Lower Limb Fracture	2.141 (1.800-2.548)	<0.001	2.127 (1.788-2.531)	<0.001	2.143 (1.801-2.549)	<0.001	2.137 (1.796-2.543)	<0.001	2.168 (1.822-2.579)	<0.001
Cervical Involvement	1.311 (1.105-1.555)	0.002	1.303 (1.098-1.546)	0.002	1.303 (1.098-1.546)	0.002	1.296 (1.092-1.538)	0.003	1.307 (1.101-1.550)	0.002
Thoracolumbar Involvement	1.295 (1.082-1.549)	0.005	1.300 (1.086-1.556)	0.004	1.300 (1.086-1.556)	0.004	1.297 (1.084-1.553)	0.005	1.302 (1.088-1.558)	0.004
Sacral Involvement	1.228 (0.912-1.652)	0.176	1.200 (0.891-1.617)	0.231	1.189 (0.882-1.603)	0.255	1.200 (0.891-1.617)	0.230	1.222 (0.908-1.645)	0.186
Northeast Region	2.020 (1.708-2.390)	<0.001	2.000 (1.691-2.366)	<0.001	1.993 (1.686-2.357)	<0.001	2.002 (1.692-2.367)	<0.001	1.990 (1.683-2.353)	<0.001
Medicaid Payment	1.217 (0.992-1.492)	0.060	1.214 (0.989-1.489)	0.063	1.210 (0.986-1.484)	0.068	1.212 (0.988-1.486)	0.065	1.214 (0.990-1.490)	0.062
Covariate										
Age	0.999 (0.996-1.003)	0.660	0.999 (0.996-1.003)	0.712	0.999 (0.996-1.003)	0.633	0.999 (0.995-1.002)	0.516	0.999 (0.995-1.002)	0.415
Model Likelihood Ratio Chi-Square	$P < 0.001$		$P < 0.001$		$P < 0.001$		$P < 0.001$		$P < 0.001$	
Nagelkerke Pseudo-R^2	0.151		0.153		0.153		0.152		0.152	

consensus exists on the role of IVCF in this population. Prophylactic IVCF insertion has been associated with lower incidence of PE in trauma patients[24–27] and in patients undergoing major spinal surgeries[28,29] compared with historic controls. The literature on this topic, however, generally involves retrospective single center studies, constituting Level III evidence. Two systematic reviews have been performed to evaluate the effectiveness of prophylactic IVCF in trauma patients, with both acknowledging the lack of high quality data and low strength of evidence to support their use.[30,31] The long term benefit of IVCF has been questioned, with some studies suggesting that their use may increase long term morbidity by causing DVT after their placement.[8–10] Largely citing the issues above, the most recent Clinical Practice Guideline published by the Consortium for Spinal Cord Medicine has recommended against the routine use of prophylactic IVCF in the setting of SCI.[32] The decision for placement of prophylactic IVCF, howeve, is often made by traumatologists or critical care intensivists for whom the Eastern Association for the Surgery of Trauma (EAST) or the American College of Chest Physicians (ACCP) guidelines are more familiar. The lack of consensus on the role of IVCF in high risk populations is underscored by the fact that the EAST and the ACCP offer conflicting recommendations.[33,34]

Despite the lack of evidence or consensus, litigation regarding the management of thromboembolic events in injured patients is relatively frequent and may influence clinician decision making. In a study analyzing 464 consecutive closed orthopaedic malpractice claims, failure to prevent, diagnose or treat pulmonary embolism as a complication of treatment had the largest "impact factor" and median payment of all the studied claims from the nation's largest liability insurer.[35] In a state-by-state analysis, Meltzer, *et al.* identified an association between indices of a litigious medicolegal environment and relative overuse of IVC filters.[36] Conversely, complications of filter placement, while rare, can be life threatening. Most notably in retrievable filters, fracture and fragment embolization resulting in cardiac perforation and tamponade have been reported.[11] As a result of these issues, three class action lawsuits have been filed against a leading manufacturer of retrievable filters, a circumstance that may further influence utilization.[37] There is currently limited data available to document existing practice regarding IVC filter use in the spine trauma population. In the aforementioned survey regarding thromboembolic practice after high risk spine surgery, spine surgeons were queried about their use of IVCF.[22] The highest percentage of respondents (37%) indicated they used filters "occasionally" if anticoagulant prophylaxis was contraindicated and 27% indicated use "occasionally" in combination with chemoprophylaxis. Few surgeons indicated they used filters all of the time or never. In the previously mentioned survey of spine trauma surgeons, 21% of respondents indicated spinal cord injury as an indication for filter placement.[23]

As opposed to a physician survey, we believe the current study presents the most detailed and objective information regarding current use of IVCF in the spine trauma population. We found that the prevalence of filter placement in patients with spine fractures and/or dislocations was 3.1%. In a study evaluating a 10 year period of the NTDB, Shackford, *et al.* reported that 4.1% of patients with vertebral fractures in the NTDB received an IVC filter.[14] With the methodology used in both the Shackford and the present study, a large number of the spinal injuries may have been relatively minor, resulting in less concern about thromboembolic events. We therefore further investigated the prevalence of prophylactic IVCF use in the subsets of operatively treated spinal injuries and spinal cord injuries, where there is both a higher risk for thromboembolic disease and more concern regarding the use of early chemoprophylaxis. We found that 8.2% of operatively treated patients with spinal injuries and 10.8% of patients with spinal cord injuries received prophylactic IVCF. Additional clinical factors which were associated with increased odds of prophylactic IVCF placement were the presence of a pelvic fracture and/or lower extremity fracture, delay in surgical management of the spinal injury, and an ISS 12 or greater. The frequency of use even in these subsets with multiple risk factors was low. Our facility level analyses demonstrated tremendous variation in the rates of prophylactic IVCF placement among patients with operatively treated spine injuries and spinal cord injury. The IQR for both of these categories revealed a greater than 10 fold variation in placement rates. This definitively underscores that there are no current standards or consensus towards IVCF use in spine injured patients even among trauma centers dedicated to the ongoing implementation of practices aimed at decreasing morbidity and mortality. While Dosset and colleagues[38] made similar observations in the general trauma population, we believe the current study is the first to rigorously analyze this issue in the spine trauma population.

We recognize that the current study has several limitations. Germane to any study utilizing national databases, the results of this study rely on the quality of the database. The NTDB-RDS contains both administratively coded and medical record abstracted data. We carefully screened the administratively coded diagnoses for inconsistencies such as conflicting codes regarding the presence or absence of a spinal cord injury in a single patient. Unlike the National Inpatient Sample (NIS), which is a claims database, the NTDB's focus is on clinical information and is submitted in a dedicated manner distinct from the reporting hospitals' efforts at reimbursement for care provided. The NTDB has implemented a data editing process with filters and data cleaning protocols including screening by a validator and rejection of files with predefined level of errors.[39,40] Even with such efforts at quality control, the NTDB-RDS is subject to the limitations of all "convenience samples." It includes a disproportionate number of larger hospitals with younger and more severely injured patients. The data may not be representative of all hospitals in the nation.

Additional limitations of our study include our criteria for defining prophylactic insertion of IVC filter. As others have,[13,14,41] we categorized patients with an IVCF and a diagnosis of DVT or PE as therapeutic and those without a diagnosis of DVT/PE as prophylactic. This approach may underestimate the number of prophylactic filters since any patient that was found to have a DVT or PE after a filter was placed earlier during their admission would be erroneously omitted from the prophylactic category and considered therapeutic. Since the number of therapeutic IVCF was comparatively small, however, the number of such potential errors would also be small. This methodology also precludes the ability to explore whether prophylactic filter placement decreases risk of PE related mortality, since we are unable to determine whether expired patients that received filters had them placed before or after a thromboembolic event. We did not attempt to investigate if the severity of spinal cord injury (complete injury versus various incomplete injuries) had an association with IVCF placement. Despite the granularity of the NTDB, other studies have suggested that utilization of ICD codes to classify spinal cord injuries leads to frequent mischaracterizations based on erroneous code selection.[42,43] In addition, since the NTDB includes patient related information only for the index admission, it is not well suited to investigate rates of filter related complications or retrievals, since these are typically issues that arise after the initial discharge. Furthermore, since the actual "reasons" for prophylactic IVCF placement are not compiled in the database, even the significant associations found here cannot be construed as establishing causation. Finally, while our intention in performing logistic regression was to determine the strength of the relationship of putative associated factors with IVCF placement while adjusting for confounding, the results of Nagelkerke pseudo-R^2 (for both models) indicate that a considerable amount of IVCF placement behavior is yet unexplained by the factors evaluated. We recognize that the timeframe for initiation of chemoprophylaxis after operative treatment of spinal injuries may be one such factor with considerable influence over the decision to place an IVCF. This information is not compiled in the NTDB-RDS so it is not possible to evaluate this issue with our approach.

Conclusion

This study utilized the largest and best validated trauma database to determine the prevalence of IVCF use in the spine trauma population. Even in the subpopulations perceived to be at highest risk for VTE (operatively treated spinal injuries, SCI), prophylactic IVCF use is relatively uncommon (8.2% and 10.8% respectively) but wide variation in their use was observed among centers. More severely injured patients and those with concomitant pelvic and lower extremity fractures were more likely to have filters placed. While this is the first study to provide objective information on current practice patterns on this issue, further study is needed to clarify the role of IVCF as part of VTE management for patients with spinal injuries.

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Conflicts of interest None.

Ethics approval None.

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